

SECTION - 30

EARTHING

1.1 a) The earth mat design shall be done by the Contractor as per IEEE-80. The main earthmat shall be laid in the switchyard area in accordance with the approved drawing.

b) The substation earthing shall be designed such a way that their rated short time withstand current is 50 KA (rms)/1 sec for 765 KV system and 63 KA (rms)/ 1sec for 400KV system.

1.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

1.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the systems are installed.

- a) code of practice for Earthing IS:3043
- b) Code of practice for the protection of Building and allied structures against lightning IS: 2309.
- c) Indian Electricity Rules 1956 with latest amendments.
- d) National Electricity safety code IEEE 80.

1.4 Details of Earthing System

Item	Size	Material
a) Main Earthing Conductor to be buried in ground	40mm dia	Mild Steel rod
b) Conductor above ground & earthing leads (for equipments)	75X12mm M.S. flat	Mild Steel
c) Conductor above ground & earthing leads (for columns & aux. structures)	75X12mm	Mild Steel

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|--|--------------------------|------------|
| d) Earthing of indoor LT panels,
Control panels and out door
Marshalling boxes, MOM
Boxes, junction boxes &
Lighting panels etc. | 50X8mm | Mild Steel |
| e) Rod Earth Electrode | 40mm dia,
5000mm long | Mild Steel |
| f) Earthing conductor
along outdoor cable trenches | 50X8mm MS Flat | Mild Steel |
| g) Earthing of Lighting Poles | 50 x 8 mm MS Flat | Mild steel |

The size of the earthing conductor indicated above are the minimum sizes.

1.5 Earthing Conductor Layout.

- 1.5.1 Earthing conductors in outdoor areas shall be buried at least 800mm below finished ground level and refilled unless otherwise.
- 1.5.2 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc, it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.
- 1.5.3 Tap connections from the earthing grid to the equipment/structure to be earthed, shall be terminated on the earthing terminals of the equipment/structure.
- 1.5.4 Earthing conductor or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. wherever it passes through walls, floors, etc., galvanized iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
- 1.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.
- 1.5.6 Earthing conductors crossing the road shall be laid 500 mm below road or at greater depth to suit the site conditions.

1.6 Equipment and Structure Earthing

- 1.6.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The Connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with owner.
- 1.6.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different section of hand rails and metallic stairs.
- 1.6.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing systems.
- 1.6.4 Metallic conduits shall not be used as earth continuity conductor.
- 1.6.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
- 1.6.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running along with the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.
- 1.6.7 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

The stone spreading shall also be done 2000 mm outside switchyard fence. The criteria for stone spreading shall be followed in line with requirement specified elsewhere in the specification.

- 1.6.9 Flexible earthing connecting of the moving parts.
- 1.6.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules.
- 1.6.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.
- 1.6.12 50mmX8mm MS flat shall run on the top ties and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be

finally painted with two coats of Red oxide primer and two coats of post Office red enamel paint.

1.6.13 A 40 mm dia, 5000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect down conductor of lightning mast and towers with peak.

1.6.14 A metallic grid (chicken mesh) to be formed along the concrete walls of the kiosk. The shell is to be connected to the substation earthmats through two links one each at the diagonally opposite corners of the kiosk.

1.7 Jointing

1.7.1 Earthing connections with equipment earthing pads be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with and corrosive paint/compound.

1.7.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type for rust protections, the welds should be treated with red lead and afterwards coated with two layer bitumen compound to prevent corrosion.

1.7.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.

1.7.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

1.7.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

1.7.6 Bending of earthing rod shall be done preferably by gas heating.

1.7.7 All arc welding with large dia, conductors shall be done with low hydrogen content electrodes.

1.7.8 All the earth flat shall be clamped with the equipment support structures at least 1000mm interval.

1.8 Power Cable Earthing Metallic sheaths and armour of all multi core power cable shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

1.9 Specific Requirement for Earthing Systems.

- 1.9.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to two electrodes in treaded earth pit (as per IS). All the earth pits in the yard to be provided with cement collar and permanent water arrangement to be done. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.
- 1.9.2 Earthing terminal of each lightning arrester & Capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.
- 1.9.3 Auxiliary earthing mat comprising of 40mm dia M.S rods closely spaced (300mm x 300mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M box of the isolators. M.O.M boxes shall be directly connected to the auxiliary earthing mat.
- 1.9.4 All earthing flats connecting to the equipments above the yard levels and upto the equipments to be painted with one coat of red oxide and green paint as per standard.
- 1.10 The earth electrode to be fabricated for 5 mts length without joints with provision for inter connecting at least two numbers earth flats from main earth mat /structures etc. The electrode to be erected by rigging 140/150 mm dia. bore using power rig and to be filled with mixer of A4 grade Bentonite powder,salt and available site soil.
- 1.10 Earth spikes to be fabricated for 3 Mts length and to be erected in lightening mast
- 1.11 600mm mean dia,300mm height,36mm thick cement collar for identification of earth electrode location including 1 primer and 2 coat of colour wash to be provided.
- 1.12 GENERAL
- 1.12.1 The sizes of flats mentioned in this specifications are indicative purposes only.The exact sizing should be decided during detailed engineering.
- 1.12.2 Combined earth resistance should be less than 0.1Ω.
- 1.12.3 Individual earth rod resistance shall be <10Ω.
- 1.12.4 The design value of step,touch,GTR & TGPR should be measured as per IEEE-80.
- 1.12.5 The multi layer soil resistivity shall be taken for the earth resistivity calculations and advance softwares like DCEGS shall be used to design the earth grid.Earthing layout and earthing design calculation prepared as above should be got approved.
- 1.12.6 Precommissioning test is to be conducted on any equipment installed at this proposed substation permitted only after the validation of earthing test as per approved earthing design.

GENERAL NOTES:-

ANNEXURE-2

1. EARTH STRIP CLEATED TO LATTICE TYPE EQUIPMENTS STRUCTURE AT AN INTERVAL OF 1000mm.
2. ALL ELECTRICAL EQUIPMENTS SHALL BE EARTHED BY TWO SEPARATE AND DISTINCT EARTH CONNECTIONS AND SHALL BE CONNECTED TO DIFFERENT CONDUCTORS OF EARTHING GRID.
3. 40 DIA mm MS ROD RISERS SHOULD BE BROUGHT CLOSE TO EQUIPMENTS FOUNDATION.
4. THE MAIN EARTH MAT SHALL BE 800mm BELOW FGL.
5. TWO NOS. ROD ELECTRODE WITH TREATED EARTH PIT SHALL BE PROVIDED FOR DG NEUTRAL.
6. TWO NOS. ROD ELECTRODE WITH TREATED EARTH PIT SHALL BE PROVIDED FOR CARRIER EQUIPMENTS (IF APPLICABLE). AND SAME SHALL BE ISOLATED FROM MAIN GRID.
7. WELDING FROM BOTH SIDE TO BE PROVIDED FOR CROSS JOINT OF FLAT/ROD.

SHEET
NO.

DESCRIPTION

2. 765kV/400kV/132kV/33kV CIRCUIT BREAKER
3. 765kV/400kV CVT & 33kV PT
4. 765kV/400kV/132kV/33kV POST INSULATOR
5. LIGHTNING ARRESTER(624kV/390kV/132kV/22kV)
6. 765kV/400kV/33kV CURRENT TRANSFORMER
7. 400kV/33kV/22kV HDB ISOLATOR & EARTH SWITCH (TYPICAL)
8. 765KV VERTICAL KNEE TYPE ISOLATOR & EARTH SWITCH (TYPICAL)
9. TOWER WITH PEAK
10. TOWER WITHOUT PEAK
11. AUXILIARY EARTH MAT FOR ISOLATOR MAIN & EARTH SWITCH MECHANISM BOX
12. ROD ELECTRODE WITH TREATED EARTH PIT
13. MARSHALLING KIOSK/OUTDOOR LIGHTING PANEL
14. LT SWITCHGEAR/CHARGER/RELAY & CONTROL PANEL/INDOOR LIGHTING PANEL
15. CABLE TRENCH

SHEET
NO.

DESCRIPTION

16. RAIL BONDING
17. TYPICAL ARRANGEMENT OF BOLTED JOINTS.
18. EARTHING OF GATE,
19. LT TRANSFORMER,
20. SINGLE PHASE 765kV/400kV/33kV ICT.
21. SINGLE PHASE 765kV REACTOR
22. AIR CORE NGR (NEUTRAL GROUNDING REACTOR),
23. WELDING DETAILS.
24. WELDING DETAILS.
25. WELDING DETAILS.
26. WELDING DETAILS.

LEGEND:-

- CONNECTION TO GROUND MAT THROUGH RISER.
- (E) ROD ELECTRODE WITH TREATED EARTH PIT
- 75X12mm MS FLAT
- 50X8mm MS FLAT
- 40mm MS ROD
- * BOLTED JOINTS.

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W.O.NO. 86009

STATUS CONTRACT

DRG./REF. NO.(INTERNAL)

CUSTOMER PROJECT:-



TAMILNADU TRANSMISSION CORPORATION. LTD.
765/400KV AIS S/S ARIYALUR IN VILLUPURAM

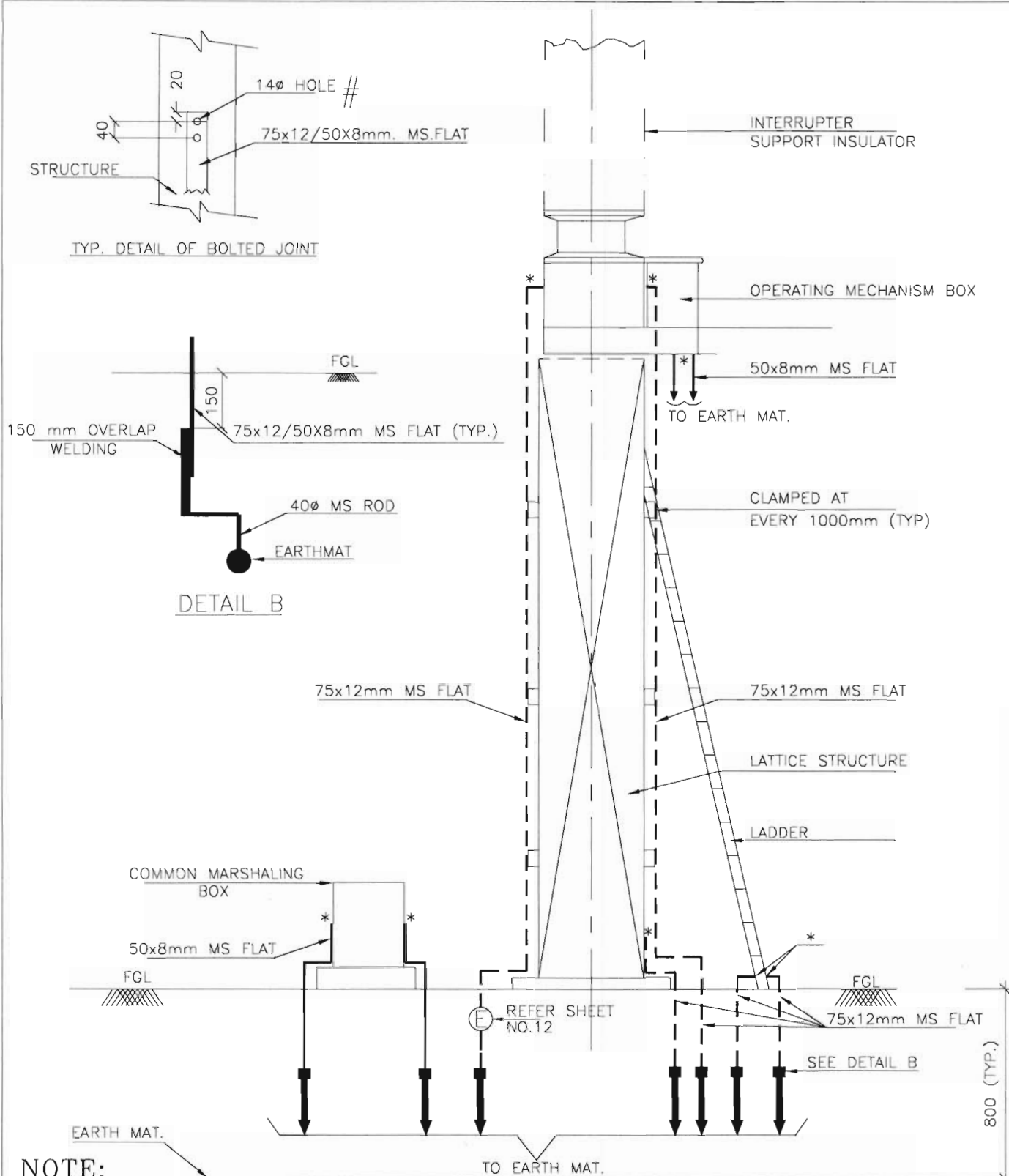


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दांसमिशन परियोजना विभाग
BHARAT HEAVY ELECTRICALS LTD
TRANSMISSION BUSINESS GROUP

DEPT CODE	NAME	SIGN.	DATE
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TITLE: EQUIPMENT & STRUCTURE EARTHING DETAILS

CV	ME	EL.	I&C	DEPT.	SCALE	BHEL/SUB VENDOR DRG NO.
				SIGN	1:800	TB-4-394-316-012
				DATE		REV. 00 SHEET No. 01



NOTE:

- # BOLT SIZE AND HOLE SIZE SHALL BE TO SUIT RESPECTIVE EQPT./STRUCTURE.
- NO. OF RISERS PER CIRCUIT BREAKER = 3 NOS. PER PHASE FOR 400kV/132kV/33kV CB.
6 NOS. PER PHASE FOR 765kV CB.
- NO. OF RISERS FOR COMMON MARSHALING BOX = 2 NOS. PER 3 PHASE FOR 765kV/400kV/132kV/33kV CB.
- * BOLTED JOINTS.
- No. OF RISER FOR OPERATING MECHANISM BOX = 2 NOS. PER PHASE FOR 400kV CB. 4 NOS. PER PHASE FOR 765kV CB.
- No. OF RISER FOR LADDER (IF APPLICABLE) = 2 NOS. PER LADDER.
- No. OF ROD ELECTRODE WITH TREATED EARTH PIT = 1 No. PER PHASE FOR 400kV/132kV/33kV CB.
2 NOS. PER PHASE FOR 765kV CB.



EQUIPMENT & STRUCTURE EARTHING DETAILS 765kV/400kV/132kV/33kV CIRCUIT BREAKER

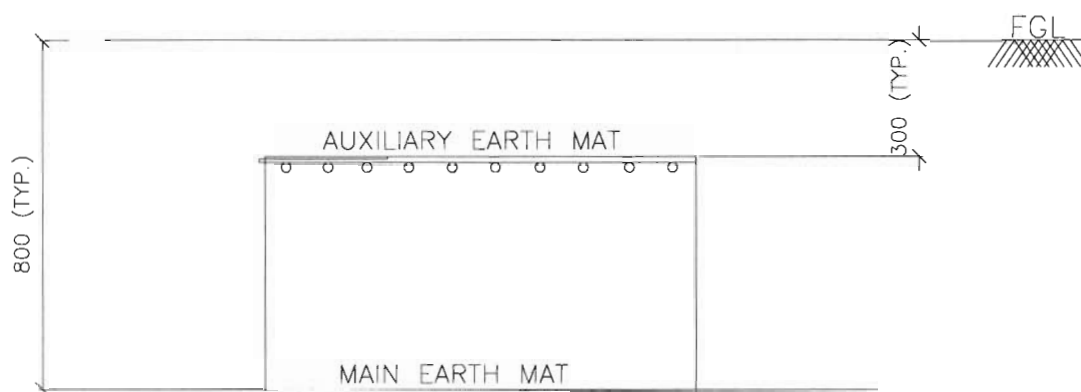
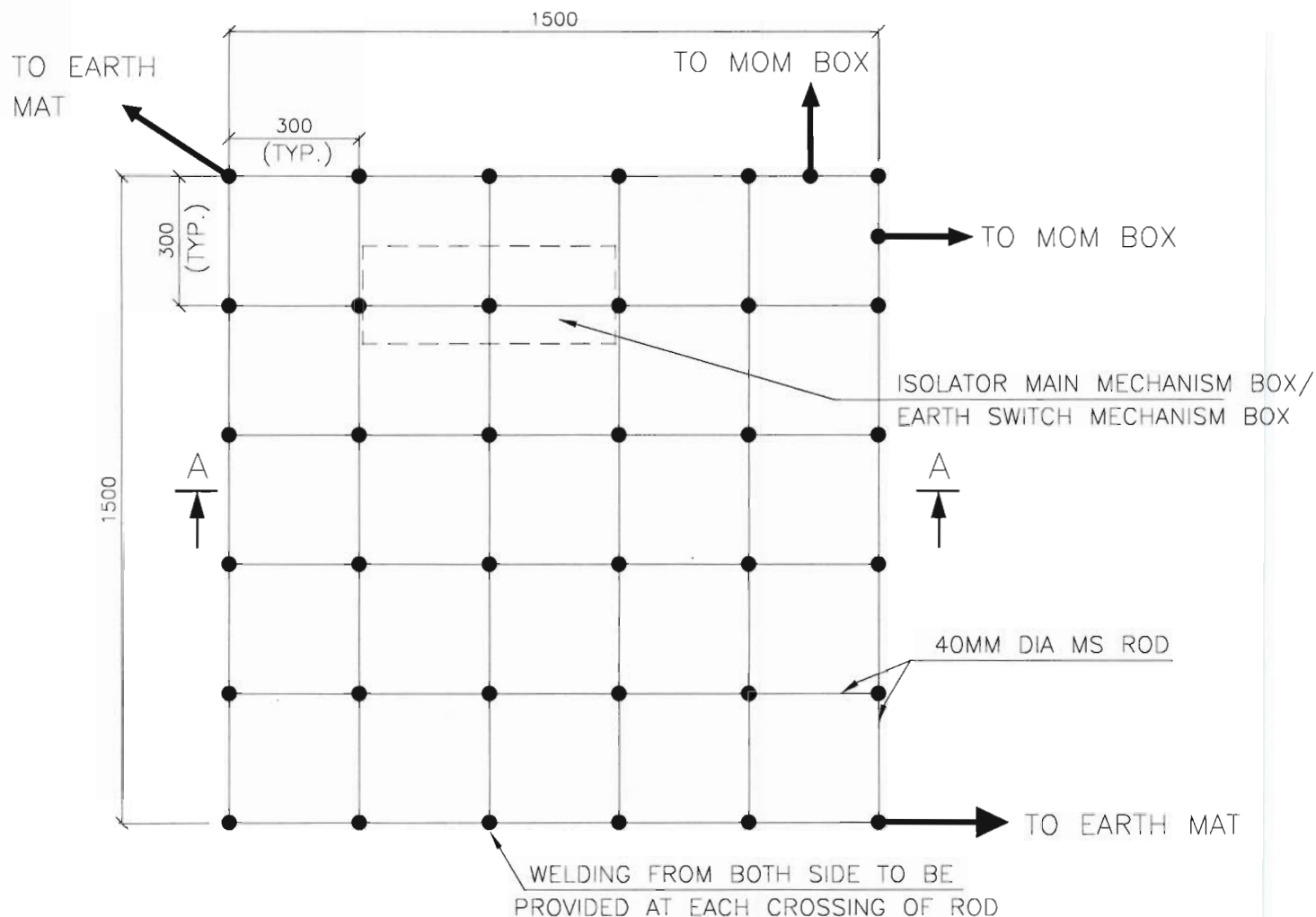
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SHEET No.
2



SECTION A - A

NOTE:

1. AUX. EARTH MAT SHALL BE SO POSITIONED THAT THE FOOT OF THE OPERATOR ALWAYS LIE OVER THE AUX. EARTH MAT AREA WHILE ATTENDING / OPERATING THE MECH. BOX THE CABLE TRENCH ROUTING SHALL BE PLANNED ACCORDINGLY.



EQUIPMENT & STRUCTURE EARTHING DETAILS

AUXILIARY EARTH MAT FOR ISOLATOR MAIN & EARTH SWITCH MECHANISM BOX

COMPU. DRG. REF.

Report No.

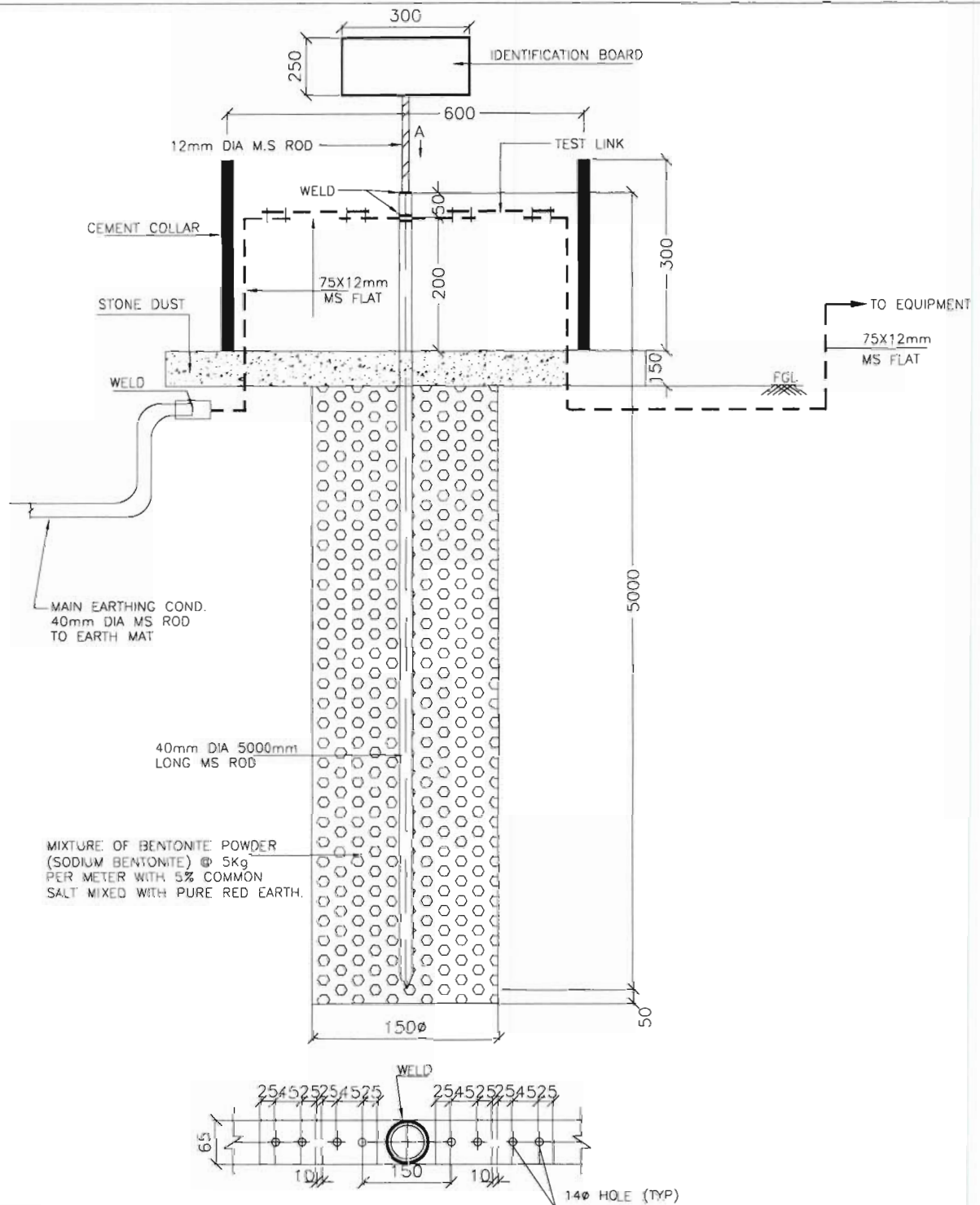
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NOTE:

1. ALL DIMENSION ARE IN mm.
2. HARDWARE HDG M12 BOLT WITH NUT,
2 PLANE AND ONE SPRING WASHER = 8 NOS. PER ELECTRODE.
3. CEMENT COLLAR IS 600 mm DIA., 300mm HEIGHT
AND 36 mm THICK. CEMENT CALLAR SHALL BE RCC TYPE.
4. 75X12mm M.S FLAT TO BE LAID UPTO EQUIPMENT FOUNDATION.
5. EXPOSED SURFACE OF CEMENT COLLAR SHALL BE PAINTED WITH TWO COATS OF PAINT OVER ONE COAT OF PRIMER.
5. IDENTIFICATION BOARD TO BE PROVIDED WITH EACH EARTH PIT.
THE SIZE OF BOARD SHALL BE 300X250mm WITH 2mm M.S SHEET ON 12mm DIA M.S ROD.

VIEW-A



EQUIPMENT & STRUCTURE EARTHING DETAILS ROD ELECTRODE WITH TREATED EARTH PIT

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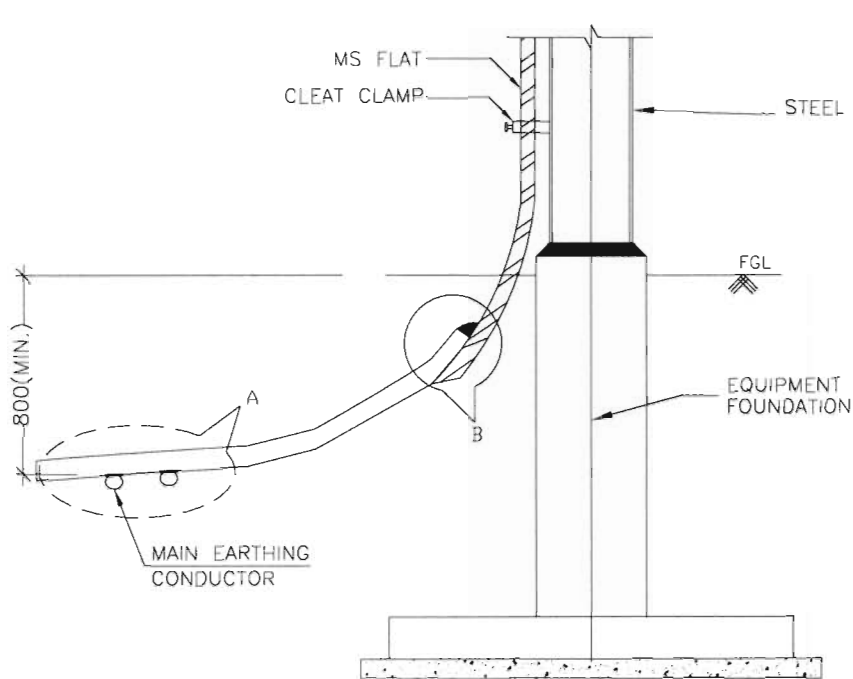
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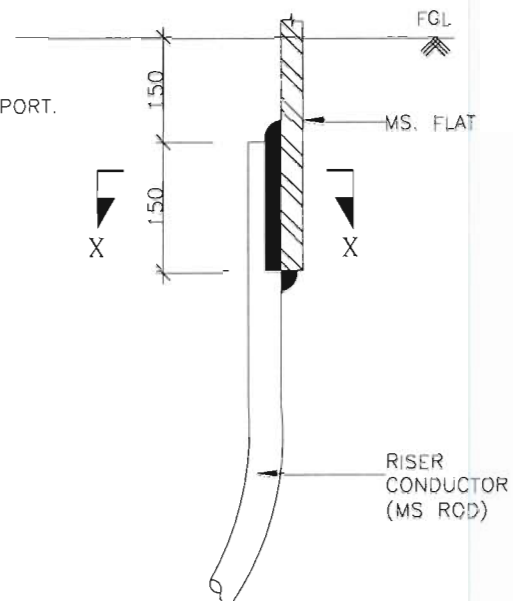
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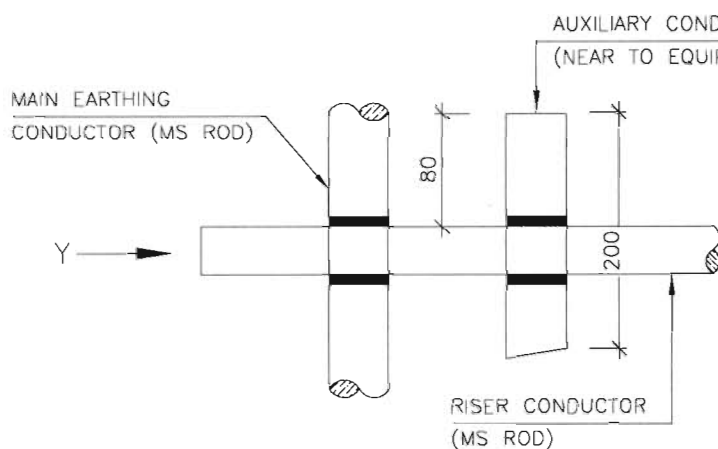
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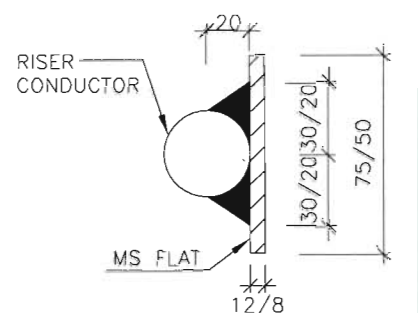
TYPICAL DETAILS OF RISER



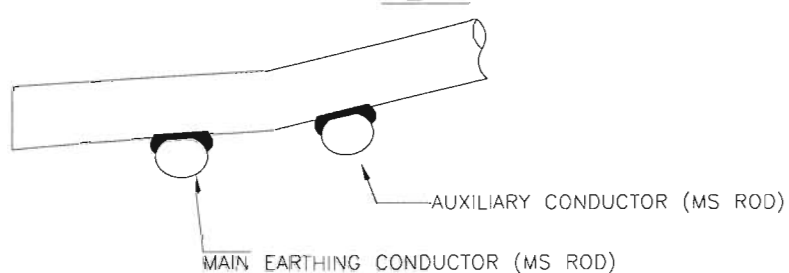
ELEVATION
DETAIL-B



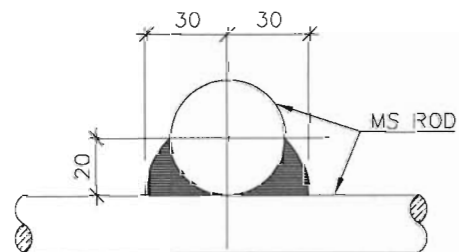
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SECTION X-X



ELEVATION
DETAIL - A



VIEW - (Y)

Saroj Kumar



EQUIPMENT & STRUCTURE EARTHING DETAILS WELDING DETAILS

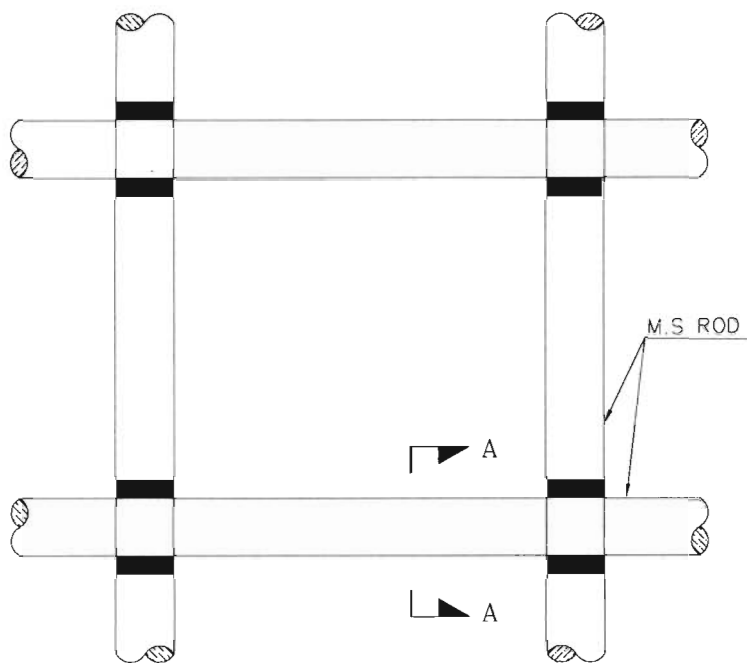
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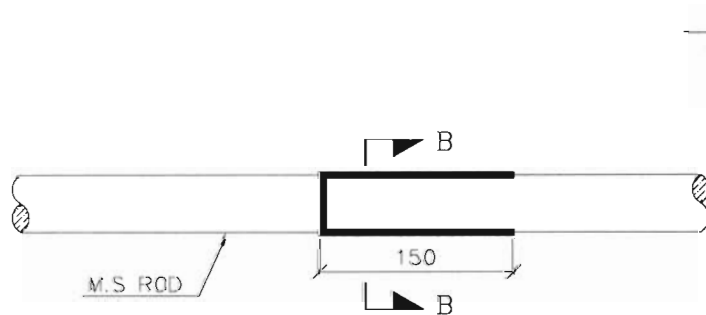
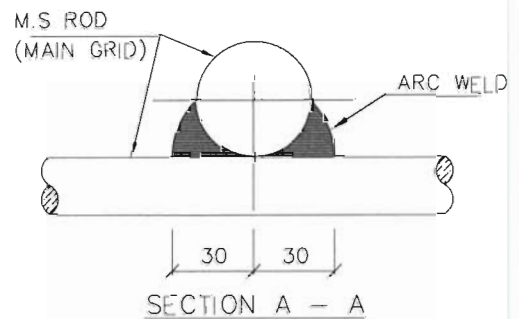
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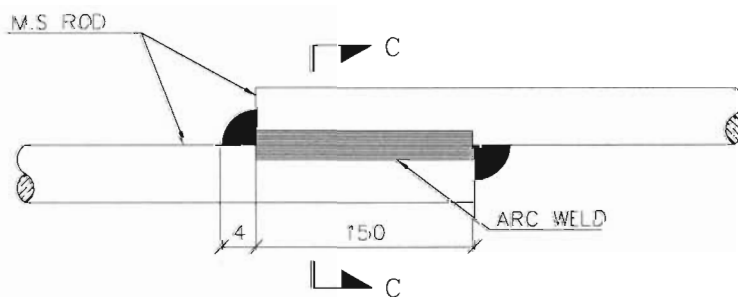
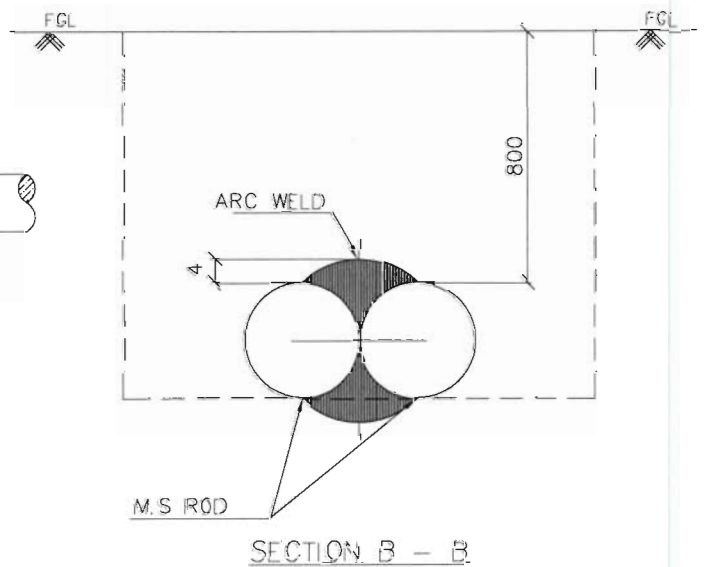
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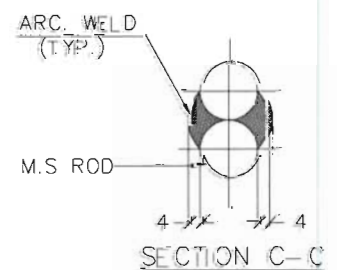
PLAN
DETAIL OF CROSS JOIN



ELEVATION
(CONDUCTORS KEPT ON SIDE)



ELEVATION
(CONDUCTORS ONE ABOVE THE OTHER)



Signature



EQUIPMENT & STRUCTURE EARTHING DETAILS

WELDING DETAILS

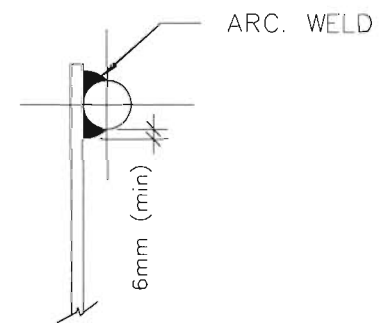
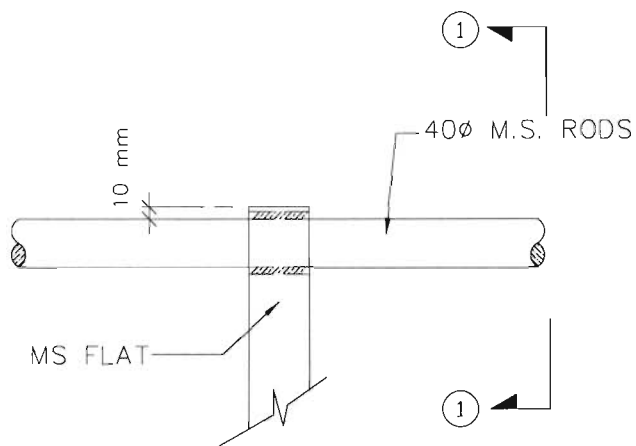
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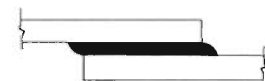
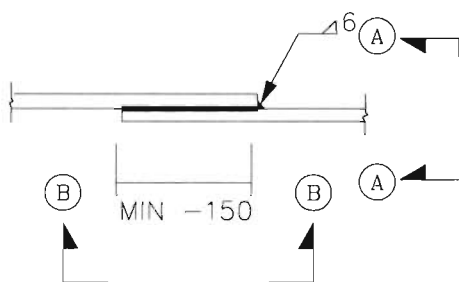
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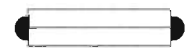


SECTION - ①

CROSS JOINT
BETWEEN M.S. ROD & MS FLATS



VIEW-B-B



VIEW-A-A

STRIP TO STRIP STRAIGHT LAP JOINT

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EQUIPMENT & STRUCTURE EARTHING DETAILS

WELDING DETAILS

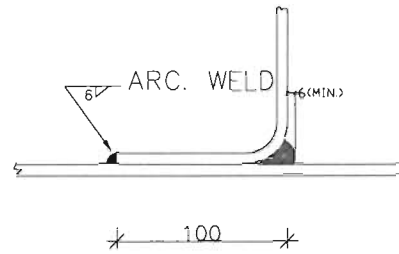
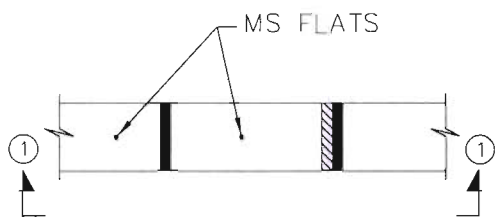
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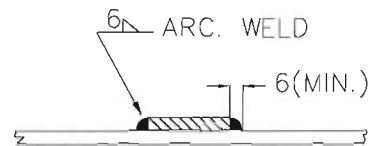
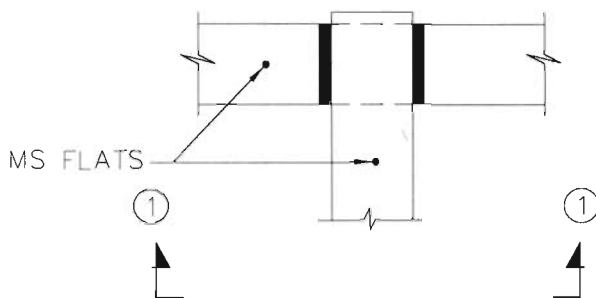
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SHEET No.
25



SECTION - ①
ANGULAR JOINT
BETWEEN MS FLATS



CROSS JOINT
BETWEEN MS FLATS

Signature



EQUIPMENT & STRUCTURE EARTHING DETAILS

WELDING DETAILS

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SHEET No.
26